#### C5.2 Decks

#### C5.2.1 General

## C5.2.1.1 Policy overview

Methods Memo No. 114: Description of Concrete Mix Types on Bridge Decks 24 March 2005 (Note that DS-01030 has been replaced by DS-09011 and DS-01033 has been replaced by DS-09012, 17 November 2009.)

With the use of high performance concrete (HPC) on bridge decks on I-235, questions have been raised about statewide policy on use of HPC and other options that are available, such as District 3's use of improved durability concrete (IDC). Also how the mixes compare and when can they be used. The following information is a description of the two types of concrete mix that have been used. A statewide policy is still under development and will be issued as more experience is gained from use of the mixes.

#### IMPROVED DURABILITY CONCRETE

District 3 implemented IDC in an attempt to enhance the life of their bridge decks by utilizing coarse aggregate meeting Class 3i durability and expediting the continuous wet burlap curing process. District 3, in consultation with the Office of Construction; put together a Developmental Specification covering the use of "Improved Durability Concrete for Bridge Decks" (DS-01030). District 3 would have preferred to use the High Performance Concrete as is being used on the I-235 corridor bridges, but was unable to due to the ready mix plant limitations of being equipped to provide slag and the third aggregate required for the HPC mix. The IDC DS was the next best approach. The developmental specification requires:

- 1. Class 3i durability aggregate
- 2. Stricter limitations on theoretical rate of evaporation during deck placement
- 3. No grooving of the plastic concrete and no placement of white pigmented curing compound (elimination of both of these aids in expediting wet burlap placement and wet curing process within 10 minutes of final finishing,
- 4. Continuous wet cure for 168 hours
- 5. The use of longitudinal grooving in the hardened bridge deck concrete.

Not all new bridge structures in District 3 are required to utilize improved durability concrete. The District decides what type of deck will be used on each structure.

Longitudinal grooving in hardened concrete is always required with IDC decks as stated in the developmental specification. However, if there are several bridge projects along the same route, the District can decide to include the longitudinal grooving bid item in the paving plan rather than the bridge plan. In the event that this occurs, the bridge plan must include a note informing the bridge contractor of the bid item change.

## HIGH PERFORMANCE CONCRETE

High performance concrete has been incorporated in the I-235 bridge projects by the Bridge office as specified in developmental specification (DS-01033). HPC; 1) improves workability, 2) reduces the permeability of the bridge decks, which reduces the contamination of salts and deicers in the deck, 3) enables increased concrete 28 day strength to 5000 psi, and 4) through the use of slag and reduction of the Portland Cement content in the mix greatly minimizes the potential for plastic shrinkage cracks in the deck.

The use of HPC, on a statewide basis is not feasible at this time. The reasons are that the HPC mix requires the addition of slag and a third aggregate. Many small ready mix concrete plants around the state do not have the plant facilities to handle slag and the required third aggregate. The additional slag component

requires a separate holding bin at the concrete plants. HPC also requires a special medium size aggregate in the mix, which would also require a separate bin. It is anticipated, with the expanding availability of slagblended cements and future gradation changes to include the third aggregate that HPC may be able to be specified on a statewide basis in the coming years. Apparently there are enough concrete plants that do not have the facilities to accommodate the slag and special aggregate and therefore would not be able to supply the HPC mix or participate in the bidding of the projects. In fact in some more remote locations of the state there are no ready mix plants within a reasonable distance of projects that could supply it.

The industry is starting to use blended cements, which incorporate the slag in the mix, therefore eliminating the need for additional facilities for the slag. However, the issue of utilizing the special aggregate in the HPC still needs to be resolved.

Longitudinal grooving in hardened concrete is also required when specifying the use of HPC as per developmental specification (DS-01033). The wet burlap cure must be in placed within 10 minutes of final finishing of the concrete. Due to this expedited wet cure requirement it is not possible to groove the concrete while it is plastic or to place white pigmented curing compound. Once again the longitudinal grooving in hardened concrete can be part of the bridge plan or the road plan depending on the situation.

For more information on High Performance Concrete feel free to contact Todd Hanson, Ahmad Abu-Hawash, John Hart – District 1 Materials, or Wayne Sunday.

A methods memo is being developed to direct designers on plan preparation using details on high performance concrete and improved durability concrete. (See Methods Memo No. 121.)

# Methods Memo No. 121: Use of Special Concrete Mixes on Bridges 8 July 2005

See C5.2.4.1.1.2.

Methods Memo No. 174: Bridge Plan Deck Dimension Table 4 September 2007

See C11.3.2.

- C5.2.1.2 Design information
- C5.2.1.3 Definitions
- C5.2.1.4 Abbreviations and notation
- C5.2.1.5 References
- C5.2.2 Loads
- C5.2.2.1 Dead
- C5.2.2.2 Live

Methods Memo No. 139: Deck Design LRFD 1 January 2008

See C5.2.2.4.

## C5.2.2.3 Dynamic load allowance

## **C5.2.2.4** Railing

Methods Memo No. 162: Bridge Railing Selection on Interstate and Primary Highways 29 June 2007

See C5.8.1.2.1.

# Methods Memo No. 139: Deck Design LRFD, Article 5.2.2.4 and 5.2.4 Bridge Design Manual LRFD 1 January 2008

The Office of Bridges and Structures has updated its bridge deck standards to LRFD and has adopted the following policies for design. These guidelines shall be used on all non-standard deck designs:

- 1. Unless otherwise specified, the approximate elastic method of analysis (LRFD 4.6.2.1) shall be used with LRFD Table A4-1.
- 2. The design shall be based on the flexure design requirement (LRFD 5.7.3). Empirical design will not be allowed.
- 3. The crack control requirement (LRFD 5.7.3.4) before the 2005 interim shall be used.
- 4. Nonstandard cantilevers with standard F-section barrier shall be designed using LRFD A13.4. and the values shown below. Please note the Mc value used in design is the average value for the F-section barriers.

#### Yield line values for F-section barrier rail

Rail rating and	$R_{\rm w}$	L <sub>c</sub>	Ave M <sub>c</sub>
condition	kips (kN)	feet (m)	ft-k (kN-m)
TL-4, interior	117 (520)	11.5 (3.510)	13.0 (17.62)
TL-4, end	74 (329)	8.0 (2.438)	13.0 (17.62)
TL-5, interior	128 (569)	16.7 (5.09)	13.9 (18.84)
TL-5, end	133.6 (594)	9.7 (2.96)	13.9 (18.84)

- 5. The optional cantilever uniform distributed line load of 1.0 k/ft will not be allowed (LRFD 3.6.1.3.4).
- 6. As a minimum, 5j1 bars should continue to be used at the gutter and the spacing should alternate between the main transverse reinforcing steel. The maximum j bars shall be limited to a no. 6 bar.
- 7. Clear cover shall be 2 ½ inches for the top reinforcing steel and 1 inches for the bottom steel.

These guidelines shall be used on any LRFD project where deck design is required because of nonstandard cross sections.

## C5.2.2.5 Earthquake

### C5.2.2.6 Construction

Methods Memo No. 183: Policy Regarding Construction Loading 1 January 2008

See C5.5.2.2.6.

## C5.2.3 Load application

### C5.2.3.1 Load modifier

#### C5.2.3.2 Limit states

## C5.2.4 Deck analysis, design, and detailing

### C5.2.4.1 Traditional decks

## C5.2.4.1.1 Analysis and design

Methods Memo No. 139: Deck Design LRFD 1 January 2008

See C5.2.2.4.

## C5.2.4.1.1.1 Analysis assumptions

### C5.2.4.1.1.2 Materials

Methods Memo No. 102: 4000 psi, 27.5 MPa Deck Concrete for Long Span BTCs and BTDs 30 December 2004 (Fewer beams require the higher strength deck concrete based on January 2007 design checks that are included in manual revisions [LRFD BDM 5.2.4.1.1.2].)

When using the longer spans of the BTC and BTD standards (BTC110, BTC115, BTC120, BTD125, BTD130 and BTD135, BTC33M, BTC35M, BTC36M, BTD38M, BTD39M, and BTD41M), the designer must specify 4000-psi (27.5 MPa) concrete for the concrete compressive strength of the bridge deck by providing the following note in the bid item reference notes:

FOR THE BRIDGE DECK CONCRETE, THE CONTRACTOR SHALL CAST A TOTAL OF SIX TEST CYLINDERS, THREE FOR 28 DAY COMPRESSIVE STRENGTH TEST AND THREE RETAINED FOR BACKUP. STRENGTH SAMPLES SHALL BE CAST, CURED, AND HANDLED IN ACCORDANCE WITH MATERIALS I.M. 315 BY AN IOWA DOT PCC LEVEL I CONCRETE FIELD TECHNICIAN OR TECHNICIAN GRADE I IN ACCORDANCE WITH ACI CP-2. THE AVERAGE STRENGTH TEST FOR THE BRIDGE DECK SHALL BE A MINIMUM OF 4000 PSI (27.5 MPa).

# Methods Memo No. 114: Description of Concrete Mix Types on Bridge Decks 24 March 2005

See C5.2.1.1.

Methods Memo No. 121: Use of Special Concrete Mixes on Bridges 8 July 2005 (Note that DS-01033 has been replaced by DS-01089, 27 June 2008.)

With the use of high performance concrete (HPC) on bridge decks on I-235 and the use of improved durability concrete (IDC) on some projects in District 3 (see MM No. 114 for description), questions have been raised about statewide policy on their use and how they should be included in the bridge projects. Therefore, for the interim use of HPC or IDC on bridge projects will only be done if requested by the District Office with the approval of the assistant bridge engineer.

When HPC or IDC is included in a bridge project the following additions should be made to the plans:

- The concrete quantity shall be separated in the concrete placement quantities table to show the
  total quantity for HPC or IDC and regular structural concrete. The slab, abutment diaphragms, pier
  diaphragms, intermediate diaphragms and wingwalls shall be designated as HPC or IDC.
  Abutment footing, wings, and paving blocks shall be regular structural concrete. The contractor
  also has the option of using regular structural concrete for the intermediate diaphragms if it is
  placed separate from the deck placement.
- 2. Include one of the following notes in the item reference notes:

#### For HPC:

THIS BID ITEM INCLUDES THE CONCRETE FOR THE SLAB, ABUTMENT, INTERMEDIATE AND PIER DIAPHRAGMS, AND WINGWALLS. REFER TO THE DEVELOPMENTAL SPECIFICATION FOR "HIGH PERFORMANCE CONCRETE FOR STRUCTURES" FOR ADDITIONAL INFORMATION. THE CONTRACTOR HAS THE OPTION OF USING REGULAR STRUCTURAL CONCRETE FOR THE INTERMEDIATE DIAPHRAGM IF IT IS PLACED SEPARATE FROM THE DECK POUR.

#### For IDC:

THIS BID ITEM INCLUDES THE CONCRETE FOR THE SLAB, ABUTMENT, INTERMEDIATE AND PIER DIAPHRAGMS, AND WINGWALLS. REFER TO THE DEVELOPMENTAL SPECIFICATION FOR "IMPROVED DURABILITY CONCRETE FOR BRIDGE DECKS" FOR ADDITIONAL INFORMATION. THE CONTRACTOR HAS THE OPTION OF USING REGULAR STRUCTURAL CONCRETE FOR THE INTERMEDIATE DIAPHRAGM IF IT IS PLACED SEPARATE FROM THE DECK POUR.

- 3. The "Trial Batch High Performance Structural Concrete" bid item is required when specifying the use of HPC as per the developmental specification (DS-01033).
- 4. Longitudinal grooving in hardened concrete is required for all bridge decks (MM No. 128). However, if there are several bridge projects along the same route, the District can decide to include the longitudinal grooving bid item in the paving plan rather than the bridge plan. In the event that this occurs, the bridge plan shall include one of the following general notes depending on whether IDC or HPC is used (E203/M203 or E204/M204) informing the bridge contractor of the bid item change.

#### E203/M203

LONGITUDINAL GROOVING OF THE BRIDGE DECK WILL BE DONE BY THE PAVING CONTRACTOR. THEREFORE, THE PORTION OF DEVELOPMENTAL SPECIFICATION FOR IMPROVED DURABILITY CONCRETE FOR BRIDGE DECKS CONCERNING THE GROOVING IS NOT APPLICABLE.

#### E204/M204

LONGITUDINAL GROOVING OF THE BRIDGE DECK WILL BE DONE BY THE PAVING CONTRACTOR. THEREFORE, THE PORTION OF THE DEVELOPMENTAL SPECIFICATION FOR HIGH PERFORMANCE CONCRETE FOR BRIDGE DECKS CONCERNING THE GROOVING IS NOT APPLICABLE.

### C5.2.4.1.1.3 Load and resistance factors

## C5.2.4.1.1.4 Section properties

### C5.2.4.1.1.5 Moment

### C5.2.4.1.1.6 Shear

## C5.2.4.1.1.7 Fatigue

### C5.2.4.1.1.8 Additional considerations

Methods Memo No. 139: Deck Design LRFD 1 January 2008

See C5.2.2.4.

## **C5.2.4.1.2** Detailing

# Methods Memo No. 51: Revision to Top of Slab Elevation Sheet 5 February 2002

To help obtain the proper setting of the top of slab elevations on bridges, elevations are to be shown at approximately 8 ft (2400 mm) to 10 ft (3000 mm) intervals in each span. Intervals should be spaced with an even number of spaces between pier bearings, so there will always be an elevation at the centerline of the span. Elevations should be given at all pier bearings.

For beam bridges, top of slab elevations in the transverse direction are to be shown at centerline approach roadway, at the parabolic crown line each side of centerline, all beam lines, each gutter line, and longitudinal construction joint if required for stage construction.

For slab bridges, top of slab elevations in the transverse direction are to be shown at centerline approach roadway, end of parabolic crown line each side of centerline, each gutter line, midpoint between end of parabolic crown and gutter line, and longitudinal construction joint if required for stage construction.

On super elevated slabs give edge of slab and gutter line elevations.

Please include this revision in all projects that are currently being developed.

# Methods Memo No. 94: T.O.S. Elevations for Beam Bridges 30 July 2004

The following revision has been made to current office policy (See Bridges and Structures Design Manual 5.2.4.1.2) and Methods Memo No. 51. For beam bridges, the top of slab elevation does not need to be provided at the parabolic crown lines. This change should be made to plans that are currently being developed.

# Methods Memo No. 198: Use of Profile Grade line on Bridge Plans 1 May 2008

A change has been made to section "5.2.4.1.2 Detailing" of the Bridge Design Manual in regard to the providing "Profile Grade Line" information on the Top of Slab Elevation sheet on the Office's bridge plans. See revision below:

"For PPCB or CWPG bridges without super-elevation, top of slab elevations in the transverse direction are to be shown at centerline of approach roadway, at profile grade

line [OBS MM No. 94], at all beam lines, at each gutter line, and at the longitudinal construction joint, if required for staged construction.

On super-elevated decks, the centerline of approach roadway, the profile grade line, the edge of slab, the gutter line, and all beam line elevations are to be shown on the plans. If a longitudinal construction joint is required for staged construction, elevations also are to be shown at the joint.

In addition, the "Profile Grade Line" should be located and identified on the "Top of Slab Elevation" sheet; however no elevations should be provided (MM No. 198)."

There has been some confusion in the field with the PGL for 4 lane divided highways. We would still like to provide the PGL location, but feel not showing the elevations would help reduce this confusion.

This revision should be made to all projects that have not yet been turned in. If you have any questions please check with me.

Methods Memo No. 208: Revision to Limits for Longitudinal Grooving (Article 5.2.4.1.2 – Detailing) 1 January 2009 (Note that Article 2412.03, D, 4, in the 2009 Standard Specifications replaces 2412.06, A, in the 2008 General Supplemental. ~ 16 June 2009)

In the 2009 Standard Specifications, Article 2412.03, D, 4, and the earlier General Supplemental the limits for calculating longitudinal grooving quantities were revised from 2 feet from the curb line to 1 foot 6 inches. Quantity calculations should be based on this revision.

This policy shall be used on all new bridge projects. If you have any question please check with me.

# Methods Memo No. 156: Revised Longitudinal Grooving Notes 4 January 2007

See C11.3.2.

Methods Memo No. 143: Longitudinal Grooving for Bridge Decks, Bridge Approaches, Bridge Deck Overlays, & Overlay of Bridge Approaches
23 November 2005

See C11.3.2.

Methods Memo No. 139: Deck Design LRFD 1 January 2008

See C5.2.2.4.

Methods Memo No. 204: General Note on Keyway Dimensions 1 August 2008

See C11.5.2.

Methods Memo No. 144: Revised Policy for Transverse Joints for CCS and PCBM Bridges 1 February 2008 (Note E925/M925 was deleted by MM No. 202.)

See C11.9.2.

# Methods Memo No. 202: Revision to Deck Placement Notes 1 October 2008

See C11.9.2.

Methods Memo No. 128: Revised Longitudinal Grooving of Bridge Decks Plan Note 3 June 2005 (The notes in this memo have been superseded by the notes in MM No. 143.)

See C11.3.2.

# Methods Memo No. 118: Longitudinal Grooving of Bridge Decks 6 April 2005

See C11.3.2.

# Methods Memo No. 121: Use of Special Concrete Mixes on Bridges 8 July 2005

See C5.2.4.1.1.2.

# Methods Memo No. 108: Longitudinal Construction Joint Placement in Decks 8 November 2005

In a discussion with the Office of Construction the question of general deck placement and constructability was reviewed. Below is a list of guidelines that designers should keep in mind when they define the deck placement sequencing in a set of plans. These guidelines were developed to open the bidding process for bridge projects to as many bridge contractors as possible and not limit this number because of overly restrictive policies.

The following are guidelines for defining deck placement sequences in general:

1. Deck widths up to and including 60 feet (gutter to gutter)

For deck widths up to and including 60 feet gutter to gutter exclusive of any sidewalk, no longitudinal construction joints are required.

2. Deck widths greater than 60 feet (gutter to gutter)

Limit the width of deck placement details on the plans to no more than 60 feet. Most bridge contractors have the deck finishing equipment capable of placing this width. Bridge plans should allow the contractor the opportunity to propose wider deck placements for approval. Permissible longitudinal construction joints should be shown on the plans and should be placed a minimum of 5 ft from the centerline of the roadway to miss the parabolic crown area.

3. Decks with variable widths

If possible, variable width bridge decks should be detailed with at least two longitudinal sections one with uniform width and a separate tapered section. The option for alternate placement sequence should be allowed for those contractors who have deck finishing equipment that is capable of placing non-uniform width decks. Construction joints shown for separate placements should be shown as permissible construction joints.

4. Closure pours

Anytime longitudinal construction joints are required, the designer needs to consider whether a closure pour is needed. Based on the Bridge Design Manual article 5.2.4.1.2, closure pours are

required if the dead load deflection of the beams is greater than 2 inches or if there is a high volume of truck traffic (> 500 per day). The extra pour is required because of difficulties in connecting deck formwork and transverse reinforcing steel because of the elevation differential between a loaded beam and an adjacent unloaded beam.

# Methods Memo No. 10: Closure Pours 30 August 2001

The following guidelines should be used when considering closure pours for bridge decks with longitudinal construction joints:

- 1. If there is more than 2 inches (50 mm) of dead load deflection in the bridge deck, then closure pours should be used.
- 2. If the stage construction is on a highway system with a high volume of truck traffic (approximately 500 or more trucks per day), then a closure pour should be considered. This will be addressed on a case by case basis, so check with your section leader

The closure pour should be wide enough to allow for splicing of the transverse reinforcing steel along with 2 inches (50 mm) of clearance for the end of the bars from the construction joint. The minimum closure pour width should be three feet (900 mm).

Closure pours should be placed in areas with constant cross-slope in the bridge deck. In addition, closure pours over beams should be avoided.

Reasons for closure pours:

- 1. For large deflections it may be difficult for the contractor to match up the elevations of the construction joints without a closure pour. Also it is difficult to tie the reinforcing steel due to the difference in elevations and possible interference with new beam lines.
- 2. For areas with high truck traffic there can be problems with vibrations due to traffic that could cause poor bonding of the concrete to the reinforcing steel adjacent to the construction joint.

If you're not sure whether a closure pour is needed, check with your section leader.

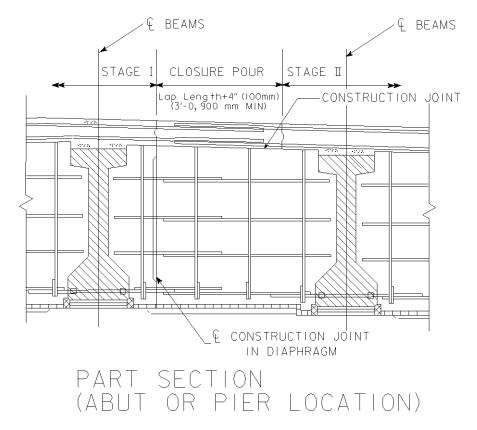
When closure pours are used, follow these guidelines for the different types of bridges:

#### 1. Concrete Slab Bridges

Closure pours are typically not used for continuous concrete slab bridges. This is because the false work is required to remain under the stage I construction until after the stage II construction has been completed and the falsework is ready for removal. Removing the false work at the same time allows the slabs from both stages to deflect under dead load together. This prevents moments from developing in the construction joint due to the slabs deflecting at different times.

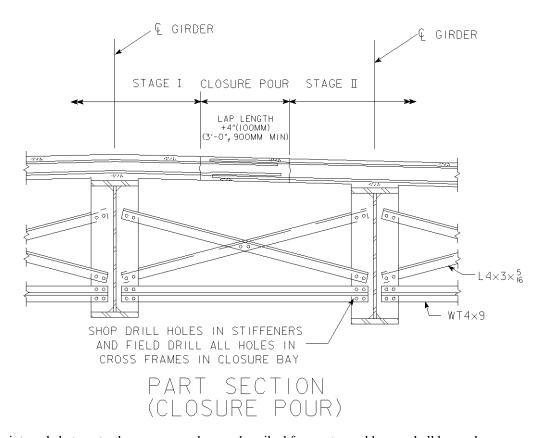
### 2. Prestressed Concrete Beam Bridges

- a. For prestressed concrete beam bridges with intermediate concrete diaphragms, the diaphragm shall not be placed in the bay where the closure pour is to be placed. See notes on CADD standard 1036A and M1036A for additional information.
- b. For prestressed concrete beam bridges with steel intermediate diaphragms, the diaphragm bolts used in connecting the channel to the bent plate shall remain loose until the second stage has been poured then tightened before the closure pour. See notes on CADD standard 1036 and M1036 for additional information.
- c. The abutment and pier diaphragms should be staged with the deck pours and be in place before the closure pour is made as shown below.



### 3. Steel Girder Bridges

The bracing in the bay that is to have the closure pour is to be installed after the second stage has been poured and prior to placing the closure pour. The bolt holes shall be field drilled in the cross bracing members to provide allowances for fit up of the diaphragm as shown below.



For integral abutments, the same procedure as described for prestressed beams shall be used.

If you have any questions, check with your section leader.

## Methods Memo No. 81: Deck Drains 24 March 2005 (Reference to Road Design Detail was corrected 23 October 2009.)

The following guidelines shall be used for determining types of deck drains and placement on bridge decks. For typical bridges, an analysis does not need to be done to determine drain spacing, if drains can be provided and spaced 25 feet to 40 feet. In situations with extremely flat grades, additional drains may have to be considered.

#### I. Bridge Deck Drain Location

- 1. Using vertical curve information, place drains at the low point of the deck if bridge is on a sag curve. If bridge is on a crest, do not place drains at the high point.
- 2. When placing drains over berms or dikes use splash basins. See Road Design Detail 4404.
- 3. Drains should be placed 10 feet or more from the centerline of a pier to keep corrosive salt water off of the piers.
- 4. For a super elevated deck, place drains on the low side only.
- 5. Drains should not be placed over traveled ways or railroad right of way.
- 6. If other choices exist, do not place drains over concrete slope protection because of erosion and settlement problems. However, placing drains over the toe of the concrete slope protection is acceptable. In addition, drains may be placed over macadam stone slope protection.
- 7. In unusual situations, a water collection system may have to be designed, such as for a finger joint expansion system over a pier support.

#### II. Drains and Extensions - Galvanize/Paint

On all bridges with tube type deck drains all parts of the drain, including bolts, concrete anchors, extensions and attachments, should be galvanized. For steel bridges, drains shall also be painted to match the color of the steel bridge (see specification 2408.30).

#### III. Selection of Type of Deck Drain

- 1. Use tube drains with angle nailer to formwork for prestressed beam and rolled steel beam bridges (CADD Standard 4380 to 4385).
- 2. Use tube drains for CWPG with two brackets attached to the web for girders that are deeper than 54 inches.
- 3. Use the aesthetic deck drain detail (CADD Standard 1054) when there is the need because of aesthetics to not have the drain located on the outside of the exterior beam or in order to avoid conflict with the top flange.
- 4. In unusual situations where additional drainage is required, check with your section leaders for options that are available such as grate drains.

#### IV. Orientation of Drain Grates

All grate drains are to be designed to orient the grate bars perpendicular to the direction of traffic thus improving the safety for motorcycles and bicycles.

Issues on eliminating deck drains are under discussion, and guidelines will be released in a later memo.

## C5.2.4.2 Empirical decks

## C5.2.4.3 Prestressed deck panels

## C5.2.4.3.1 Analysis and design

### C5.2.4.3.1.1 Design criteria

**C5.2.4.3.1.2** Materials

### C5.2.4.3.1.3 Additional considerations

## **C5.2.4.3.2** Detailing

#### C5.2.4.4 Two-course decks

Methods Memo No. 95: Deck Overlays on New Construction 30 December 2004 (In Attachment A the reference in the note to the 2009 Standard Specifications is 2413.03, B, changed from 2413.04 in the 2001 Standard Specifications. ~ 16 June 2009)

Although the office policy for typical bridge decks is to use a single course, 8-inch (200 mm) thick concrete deck with a ½-inch (13-mm) integral wearing surface and dead load for a future wearing surface, that policy does not apply for all bridges. For special designs, the designer may consider a two-course deck. The two-course deck requires approval of the Chief Structural Engineer or the Assistant Bridge Engineer.

The two-course deck shall be designed and constructed according to the following policies.

1. No load shall be included in the design for a future wearing surface. At such time that the wearing surface no longer is serviceable, the entire upper course of the deck will be removed and replaced without adding load to the structure.

- 2. The upper course of the deck shall be two inches (50 mm) thick.
- 3. The upper course shall not be considered as composite with floor beams or girders.
- 4. The concrete finish on the lower course shall be according to plan note. See Attachment A.
- 5. The lower, structural course of the deck shall be at least 8 inches (200 mm) thick, which shall be the design thickness. Thicknesses greater than 8 inches (200 mm) shall be used as required for relatively long deck spans.
- 6. In the lower course, cover above the top mat of reinforcement shall be 1.0 inch (38 mm).
- 7. Where appropriate shear connection is provided (positive bending regions), the lower, structural course may be considered composite with floor beams or girders.

If the bridge with the two-course deck has a sidewalk with no overlay, two additional issues need to be addressed.

- 1. Cover of 1.0 inch (38 mm) will not be adequate in the sidewalk area or the deck overhang. Separate transverse bars in the sidewalk area need to be placed in order to achieve 2.5 inch (65 mm) cover, as for single course decks.
- 2. Allowance for a future wearing surface in the sidewalk area needs to be included in the long-term dead load (DL2).

#### Attachment A

PLAN NOTE: Preparation of Surface for Surfacing (Two-Course Deck)

THE TOP SURFACE OF CONCRETE DECK SHALL BE INTENTIONALLY ROUGHENED OR RAKED TO A MINIMUM DEPTH OF 6 MM (1/4"). THE ROUGHENING OF THE DECK SHALL BE DONE WITH A MECHANICAL DEVICE SUCH AS WIRE BROOM OR TINING RAKE. TINING CAN BE TRANSVERSE OR LONGITUDINAL. TEXTURE RAKE TINE SPACING SHALL BE EQUAL SPACES OF 1 ½ INCH OR UNEQUAL SPACES IN ACCORDANCE WITH ARTICLE 2412.06 OF THE STANDARD SPECIFICATIONS.

THIS OPERATION SHALL BE DONE AT SUCH TIME AND MANNER THAT THE DESIRED SURFACE TEXTURE WILL BE ACHIEVED WHILE MINIMIZING DISPLACEMENT OF THE LARGER AGGREGATE PARTICLES AND BEFORE THE SURFACE PERMANENTLY SETS. THIS OPERATION SHALL NOT DELAY THE PLACEMENT OF WET BURLAP WITHIN THE ALLOTTED TIME AS SPECIFIED BY THE APPROPRIATE SPECIFICATIONS.

ADDITIONAL REQUIREMENTS AS SPECIFIED IN **ARTICLE 2413.03**, **B**, OF THE STANDARD SPECIFICATIONS SHALL APPLY.

C5.2.4.4.1	Analysis and design
C5.2.4.4.2	Detailing

Appendix for obsolete and superseded memos